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Case Study

# STUDIES ON PROPAGATION THROUGH STEM CUTTINGS AND EFFECT OF BIOFERTILIZERS ON GROWTH OF *OCIMUM KILIMANDSCHARICUM G.* IN ODISHA CONDITION

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***ABSTRACT***

***The present investigation "Studies on propagation through stem cuttings and effect of biofertilizers on growth of Ocimum kilimandscharicum G." was carried out with the objective to study the propagation of Ocimum kilimandscharicum through cuttings and the effect of different biofertlisers on its biomass yield.***

***In the first experiment the effect of IAA and IBA in different concentrations (50 ppm, 100 ppm, 200 ppm, 400ppm, 500ppm, 1000ppm, 2000ppm and Control) on rootings and growth parameters of apical and middle portion cuttings of Ocimum kilimandscharicum G. in two different lengths of 10 cm and 20 cm was studied .Middle portion Cuttings of 20cm length treated with 2000 ppm IAA showed maximum no.of leaves per plant (94.00), root length (28.50cm), fresh root biomass (3.83 g), oven dry root biomass (1.00g), fresh shoot biomass (33.86g), oven dry shoot biomass (5.58g), total fresh biomass(37.69g) and total oven dry biomass (6.58g). However, Collar diameter (0.50cm) was found to be statistically at par with the maximum value (0.53cm). The cutting type also shows high sprouting percentage (83.66%), plant height (60.50 cm), rooting percentage (80.00%) and no. of branches per plant (3.00).***

***In the second experiment, the effect of various biofertilisers, organic and chemical fertiliser on growth and biomass yield of Ocimum kilimandscharicum was studied. Eleven different treatments were applied to seedlings raised in separate plots of size 1.2m x 1.0 m at spacing of 40cm x 30cm with various doses of biofertilisers, organic, chemical fertilizer and without any fertiliser. Among all treatments plants treated with $T_3$ gave maximum collar diameter (1.35cm), number of branches (15.50), no.of leaves per plant (356.50), fresh leaf biomass per plant (79.16g), fresh stem biomass (300.56g), total fresh biomass (425.28g), fresh leaf biomass yield per hectar (6.59 tonne), oven dry stem biomass (163.69g), total oven dry biomass (201.55g) . Plant height (107.81cm), Root length (35.83cm) recorded for $T_3$ are found to be statistically at par with maximum values of plant height (110.40cm) and root length (36.16cm) respectively. It also records higher values in fresh root biomass (45.56g) and oven dry leaf biomass (18.05g). Among biofertilisers and its combinations, Plants applied with $T_8$ recorded highest Plant height (110.40g), Collar diameter (1.29cm), root length (35.83cm), fresh root biomass (57.80g), fresh leaf biomass (71.65g), fresh stem biomass (238.92g), total fresh biomass (368.37g), fresh leaf biomass yield per hectare (5.97 tonnes), oven dry root biomass (29.33g), oven dry leaf biomass (20.42g), oven dry stem biomass (140.27g), total oven dry biomass (190.02g) and oven dry biomass yield per hectare (1.70 tonne) . No.of branches (11.33) and no. of leaf (253.77) were also observed higher values for the respective plant characters among all treatments of biofertiliser applications.***

***KEYWORDS: Fresh Root Biomass, Oven Dry Root Biomass & Rooting Percentage***

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## INTRODUCTION

Medicinal plants are an important source of compounds for the pharmaceutical industry and traditional medicine. About 80% of the population living in developing countries still use traditional medicines derived from plants for their primary health care needs (De Silva, 1997). About13,000 species of plants have been employed for at least a century as traditional medicines by various cultures around the world (Tyler 1993).The success of any health care system depends on the availability of suitable drugs on a sustainable basis. Although synthetic drugs and antibiotics are essential for current medical practice, plants provide a major contribution to the pharmaceutical industry (Sahoo *et al*., 1997). Unfortunately, rapid industrialization and urbanization has led to overexploitation and loss of valuable natural resources including medicinally important herbaceous plants. Many species are subject to extensive, unregulated collection and are endangered or threatened with extinction (Sudha and Seeni, 1994).

*Ocimum kilimandscharicum* Guerke is an economically important medicinal perennial herb originating from the Kilimandscharo hill in Africa and belongs to family Lamiacea. It is an aromatic herb with pubescent quadrangular branchlets. This plant is easily recognized by its shrub by habit growing up to 1-1.5m height. The leaves are ovate to broadly elliptic; acute dentate, pubescent on both the surfaces and about 6cm long, when bruised emits a strong camphor smell. The flowers are pale yellow or pinkish white in colour and occur in 4-6 whorls. This plant has attracted attention as a source of camphor. It is native to East Africa and distributed in Central and Southern America, India and Thailand. It can be grown in plains as well as in the hills both in tropical (Demissew and Asfaw, 1994) and subtropical climate up to an altitude of 900m with well distributed rainfall 125cm annually or even less. In India, it is cultivated on a small scale especially in West Bengal, Assam, Tamil Nadu, Karnataka, Kerala and Dehradun .

In traditional medicine this plant is widely used for the treatment of various ailments including colds, coughs, abdominal pains, measles and diarrhoea (Obeng-Ofori *et al.,* 1998). Extracts of the plant have been shown to possess wound healing, antidiarrhoeal, antinociceptive and antiamnesic activities and the plant possess oviposition deterrence activities.

*Ocimum killimandscharicum* is characterized by presence of high amount of camphor in essential oil. It is pale yellow in color and its content varies in different samples from 61 to 80.5%. The camphor obtained from leaf oil is used in large quantities for religious purposes in India. It is used in manufacturing of celluloid and explosives, plasticizer, various pharmaceutical preparations, disinfectant, tooth paste, powder and ointments. Leaves contain the maximum amount of camphor and oil followed by flowers, stems contain only minute quantities. The seed oil of *Ocimum kilimandscharicum* also contains camphor as the most active component (Jembere *et al*., 1994). The oil contains d-camphor, d-α-pinene, d-limonene, terpinolene and unidentified esquiterpenes and sesquiterpenes of alcohols (Gill *et al.,* 2012). The oil also contains biologically active constituents that act as insect repellents, particularly against mosquitoes and storage pests (Kweka *et al*., 2008) or show antibacterial (Prasad *et al.,* 1986) and antioxidant activity (Hakkim *et al*., 2008).

The major difficulty in the use of Lamiaceae species for pharmaceutical purposes is its individual variability, due to genetic and biochemical heterogenicity (Dode *et al.,* 2003). The conventional method of propagating this species is through seeds but seed viability is very poor and low germination limits its multiplication. Moreover, seed derived progenies are not true to type, due to cross-pollination (Heywood, 1978) and tissue culture requires specialized skill and laboratories. So in order to produce mass propagation of quality planting material of *Ocimum kilimandscharicum* vegetative propagation through cutting is the best method. Yield as well as active principles content in *Ocimum*

*kilimandscharicum* depends on the package of practices for the cultivation and adoption of modern agro- techniques. Application of biofertlisers causes improvement of the soil fertility, increases crop yield, provides protection against drought and some soil-borne diseases besides being high market value of organic cultivation products. Biofertiliser application also increases the biomass yield in other Ocimum species (Shanmuga Priya *et.al.*, 2013).

In view of the importance of the mass production of quality planting material of *Ocimum killimandscharicum* and identifying proper biofertiliser for maximizing biomass yield and good growth, it was thought imperative to undertake studies with the following objectives.

- To study propagation of *Ocimum killimandscharicum* through cuttings
- To study the effect of different biofertlisers on biomass yield of *Ocimum killimandscharicum.*

## REVIEW OF LITERATURE

Karimi *et al.* (2014) studied the vegetative propagation of *Thymus satureioides* by cutting and reported that the untreated basal cuttings have a low average rate of rooting (11%), however the hormone treatment showed significant differences in the rooting rate (25%) at higher concentrations of auxin (500 ppm).

Elhaak *et al*. (2014) studied the propagation in using Indole-3-Butyric Acid for rooting *Rosmarinus officinalis* stem cutting. Indole-3-butyric acid (IBA) was applied in various concentration and dipped for one, three, six hours and rooting percentage, root length and rosmarinic acid, phenolic and alkaloids contents in the cutting raised plants were studied. Results reaveled that maximum root number obtained was five times the control value and was achieved by soaking the cuttings three hours in 60 ppm IBA. The cutting length found to be increased by 4% when soaked for six hours in 40ppm IBA and the rosemarinic acid was estimated to be increased by 5.6% when the cutting treated with 60ppm IBA .

Jokar *et al.* (2015) studied the effect of organic fertilizers and biological characteristics on the growth, yield and morphological characteristics of medicinal plant *Echinea purpurea*. The factor of organic fertilizers include manure application in three levels , 5 and 10 tons per hectare and control consumption and bio-fertilizer on plots with four levels of bacteria, *Pseudomonas putida, Azospirillum lipoferum, Pseudomonas + Azospirillum* and control. The study revealed that the application of biological fertilizers leads to increase in height, flower number, number of leaves, the size of the canopy, leaf dry weight, shoot weight as compared to the control.

## MATERIALS AND METHODS

### Experimental Detail

The detail of experiment is given below.

### Experiment 1

Study on propagation of *Ocimum kilimandscharicum* through cuttings

### Preparation of Rooting Media

Rooting media was prepared by mixing sieved sand, soil and FYM in ratio of 1:2:1. It was then filled in polypot of size 20×10 cm leaving a gap of 1.5 cm from the top.

**Figure 1: *Ocimum Killimandscharicum* G.**

**Source of Cutting and Their Preparation**

Apical and middle portion cutting of *Ocimum kilimandscharicum* were collected from from selected branches of plants grown in research plot of College of Agriculture, Bhubaneswar, Odisha. From each of apical and middle portion cutting types healthy cutting of 10 cm and 20 cm length having more than 5 nodes with in thickness <0.3 cm prepared during the month of March 2015.

**Preparation of Growth Regulator Formulations**

The stock solution of 50 ppm, 100 ppm, 200 ppm, 400 ppm, 500 ppm, 1000 ppm and 2000 ppm of each IAA and IBA was prepared separately. IAA and IBA were weighed in digital weighing balance dissolved in little quantity of 95% Ethyl alcohol and later the volume was made up to 1000ml by adding distil water. Pure distill water was taken as control.

**Treatment of Cutting, Planting and After Care**

The basal position of each cutting types collected from apical and middle portion of the plant were dipped in Bavistin solution (0.15%) for 5 minutes and then washed in distilled water, air dried and then dipped 1.5- 2.00 cm with above growth regulator concentrations of IAA and IBA respectively for 1min . The cuttings were planted in the polypots filled with rooting media and watered as per the requirement . Polypots were put under agroshed net from the month of March onwards.

**Treatment Details**

**Table 1**

| | |
|---|---|
| $T_{1.}$ | **10 cm Length Apical Cutting Treated with 50 ppm IAA** |
| $T_{2.}$ | 10 cm length apical cutting treated with 100 ppm IAA |
| $T_{3.}$ | 10 cm length apical cutting treated with 200 ppm IAA |
| $T_{4.}$ | 10 cm length apical cutting treated with 400 ppm IAA |
| $T_{5.}$ | 10 cm length apical cutting treated with 500 ppm IAA |
| $T_{6.}$ | 10 cm length apical cutting treated with 1000 ppm IAA |
| $T_{7.}$ | 10 cm length apical cutting treated with 2000 ppm IAA |
| $T_{8.}$ | 10 cm length apical cutting treated with 50 ppm IBA |
| $T_{9.}$ | 10 cm length apical cutting treated with 100 ppm IBA |
| $T_{10.}$ | 10 cm length apical cutting treated with 200 ppm IBA |
| $T_{11.}$ | 10 cm length apical cutting treated with 400 ppm IBA |
| $T_{12.}$ | 10 cm length apical cutting treated with 500 ppm IBA |
| $T_{13.}$ | 10 cm length apical cutting treated with 1000 ppm IBA |
| $T_{14.}$ | 10 cm length apical cutting treated with 2000 ppm IBA |
| $T_{15.}$ | 20 cm length apical cutting treated with 50 ppm IAA |
| $T_{16.}$ | 20 cm length apical cutting treated with 100 ppm IAA |

| Table 1: Contd., | |
|---|---|
| $T_{17.}$ | 20 cm length apical cutting treated with 200 ppm IAA |
| $T_{18.}$ | 20 cm length apical cutting treated with 400 ppm IAA |
| $T_{19.}$ | 20 cm length apical cutting treated with 500 ppm IAA |
| $T_{20.}$ | 20 cm length apical cutting treated with 1000 ppm IAA |
| $T_{21.}$ | 20 cm length apical cutting treated with 2000 ppm IAA |
| $T_{22.}$ | 20 cm length apical cutting treated with 50 ppm IBA |
| $T_{23.}$ | 20 cm length apical cutting treated with 100 ppm IBA |
| $T_{24.}$ | 20 cm length apical cutting treated with 200 ppm IBA |
| $T_{25.}$ | 20 cm length apical cutting treated with 400 ppm IBA |
| $T_{26.}$ | 20 cm length apical cutting treated with 500 ppm IBA |
| $T_{27.}$ | 20 cm length apical cutting treated with 1000 ppm IBA |
| $T_{28.}$ | 20 cm length apical cutting treated with 2000 ppm IBA |
| $T_{29.}$ | 10 cm apical cutting treated with water |
| $T_{30.}$ | 20 cm apical cutting treated with water |
| $T_{31.}$ | 10 cm length middle portion cutting treated with 50 ppm IAA |
| $T_{32.}$ | 10 cm length middle portion cutting treated with 100 ppm IAA |
| $T_{33.}$ | 10 cm length middle portion cutting treated with 200 ppm IAA |
| $T_{34.}$ | 10 cm length middle portion cutting treated with 400 ppm IAA |
| $T_{35.}$ | 10 cm length middle portion cutting treated with 500 ppm IAA |
| $T_{36.}$ | 10 cm length middle portion cutting treated with 1000 ppm IAA |
| $T_{37.}$ | 10 cm length middle portion cutting treated with 2000 ppm IAA |
| $T_{38.}$ | 10 cm length middle portion cutting treated with 50 ppm IBA |
| $T_{39.}$ | 10 cm length middle portion cutting treated with 100 ppm IBA |
| $T_{40.}$ | 10 cm length middle portion cutting treated with 200 ppm IBA |
| $T_{41.}$ | 10 cm length middle portion cutting treated with 400 ppm IBA |
| $T_{42.}$ | 10 cm length middle portion cutting treated with 500 ppm IBA |
| $T_{43.}$ | 10 cm length middle portion cutting treated with 1000 ppm IBA |
| $T_{44.}$ | 10 cm length middle portion cutting treated with 2000 ppm IBA |
| $T_{45.}$ | 20 cm length middle portion cutting treated with 50 ppm IAA |
| $T_{46.}$ | 20 cm length middle portion cutting treated with 100 ppm IAA |
| $T_{47.}$ | 20 cm length middle portion cutting treated with 200 ppm IAA |
| $T_{48.}$ | 20 cm length middle portion cutting treated with 400 ppm IAA |
| $T_{49.}$ | 20 cm length middle portion cutting treated with 500 ppm IAA |
| $T_{50.}$ | 20 cm length middle portion cutting treated with 1000 ppm IAA |
| $T_{51.}$ | 20 cm length middle portion cutting treated with 2000 ppm IAA |
| $T_{52.}$ | 20 cm length middle portion cutting treated with 50 ppm IBA |
| $T_{53.}$ | 20 cm length middle portion cutting treated with 100 ppm IBA |
| $T_{54.}$ | 20 cm length middle portion cutting treated with 200 ppm IBA |
| $T_{55.}$ | 20 cm length middle portion cutting treated with 400 ppm IBA |
| $T_{56.}$ | 20 cm length middle portion cutting treated with 500 ppm IBA |
| $T_{57.}$ | 20 cm length middle portion cutting treated with 1000 ppm IBA |
| $T_{58.}$ | 20 cm length middle portion cutting treated with 2000 ppm IBA |
| $T_{59.}$ | 10 cm middle portion cutting treated with water |
| $T_{60.}$ | 20 cm middle portion cutting treated with water |

**Design and Layout of Experiment**

The experiment was layout in Randomized Block Design. There were 60 treatments of different concentrations of

growth regulator applied to cutting types .Three replications were taken for each treatment and 10 cuttings were grown for each replication.

## OBSERVATIONS RECORDED

### Sprouting Percentage

The total number of cuttings that sprouted under each treatment were counted and expressed as sprouting percentage.

$$\text{Sprouting percentage (\%)} = \frac{\text{Number of cutting sprouted}}{\text{Total number of cutting planted}} \text{ X } 100$$

### Rooting Percentage

The total number of cutting within each treatment which showed the growth of root (≥ 1mm) were counted and expressed in percentage.

$$\text{Rooting Percentage (\%)} = \frac{\text{Number of cutting rooted}}{\text{Total number of cutting planted}} \text{ X } 100$$

## RESULTS

The result obtained during the present course of investigation "Studies on propagation through stem cuttings and effect of biofertilizers on growth of *Ocimum kilimandscharicum*" are presented in this chapter as under:

### Studies on Propagation of *Ocimum kilimandscharicum* through Cuttings

In this investigation the study was carried out to visualize the effect if IAA and IBA in different concentrations (50 ppm, 100 ppm, 200 ppm, 400 ppm, 500 ppm, 1000ppm, 2000ppm and Control) for rootings and growth parameters on apical and middle portion cuttings of *Ocimum kilimandscharicum* in two different lengths of 10cm and 20cm. The observation were recorded after 3 months of planting of cuttings in polybags for sprouting percentage, plant height (cm), collar diameter (cm), no. of branches/plant, no. of leaves/plant, green shoot biomass (g), oven dry shoot biomass (g), rooting percentage, root length (cm), fresh root biomass (g), oven dry root biomass (g), total fresh biomass (g) and total oven dry biomass (g).

### Studies on Effect of Various Concentration of IAA and IBA on Sprouting Percentage in Different Type of Cuttings of *Ocimum kilimandscharicum*

The effect of different treatments i.e. cutting types treated with auxins, various concentration and interaction of both on sprouting percentage in cuttings of *Ocimum kilimandscharicum* were found highly significant under given table 1.

The mean value of sprouting percentage (averaged over all concentration) was found maximum (82.46%) in apical cutting of 20 cm length treated with IAA. The lowest mean value of sprouting percentage (64.28 %) was found in apical cutting of 20 cm length treated with IBA.

The mean value of sprouting percentage (averaged over all cutting types treated with auxins) was found maximum (79.66%) in cuttings treated 1000 ppm concentration, however, the lowest mean value of sprouting percentage (64.99%) was recorded in cuttings treated with 2000 ppm concentration of auxins. Maximum sprouting percentage among all treatment combinations (100.00%) was obtained in middle portion cutting of 20 cm length treated with 1000 ppm IAA, where as no sprouting was found in case of 20 cm length apical cuttings treated with 2000 ppm and 1000 ppm IBA.

**Table 1: Effect of IAA & IBA on Sprouting Percentage of *Ocimum killimandscharicum***

| Cutting Type | Control | 50 PPM | 100 PPM | 200 PPM | 400 PPM | 500 PPM | 1000 PPM | 2000 PPM | Mean |
|---|---|---|---|---|---|---|---|---|---|
| Apical 10cm cutting treated with IAA | 73.33 (1.871) | 63.33 (1.808) | 73.33 (1.871) | 83.33 (1.926) | 83.33 (1.926) | 86.66 (1.943) | 86.33 (1.941) | 86.33 (1.941) | 80.74 (1.903) |
| Apical 20cm cutting treated with IAA | 63.33 (1.808) | 83.33 (1.926) | 93.33 (1.975) | 83.36 (1.926) | 83.36 (1.926) | 73.33 (1.871) | 93.33 (1.975) | 86.33 (1.941) | 82.46 (1.918) |
| Apical 10cm cutting treated with IBA | 73.33 (1.871) | 73.33 (1.871) | 73.66 (1.873) | 73.66 (1.873) | 73.33 (1.871) | 63.33 (1.808) | 73.66 (1.873) | 63.33 (1.808) | 70.95 (1.856) |
| Apical 20cm cutting treated with IBA | 63.33 (1.808) | 73.66 ((1.873) | 73.33 (1.871) | 73.33 (1.871) | 73.33 (1.871) | 73.66 (1.873) | 83.66 (1.928) | 0.00 | 64.28 (1.637) |
| Middle portion 10cm treated with IAA | 73.66 (1.873) | 63.66 (1.811) | 73.33 (1.871) | 63.33 (1.808) | 63.33 (1.808) | 63.33 (1.808) | 63.66 (1.811) | 63.33 (1.808) | 65.95 (1.825) |
| Middle portion 20cm treated with IAA | 83.66 (1.928) | 93.36 (1.975) | 63.66 (1.811) | 83.66 (1.928) | 73.66 (1.873) | 83.33 (1.926) | 100.00 (2.004) | 83.66 (1.928) | 83.12 (1.921) |
| Middle portion 10cm treated with IBA | 73.33 (1.871) | 63.66 (1.811) | 83.66 (1.928) | 93.66 (1.976) | 63.66 (1.811) | 73.66 (1.873) | 63.33 (1.808) | 63.66 (1.811) | 71.07 (1.863) |
| Middle portion 20cm treated with IBA | 83.33 (1.926) | 83.66 (1.928) | 96.33 (1.988) | 73.66 (1.873) | 73.66 (1.873) | 73.33 (1.873) | 73.33 (1.873) | 73.33 (1.871) | 80.49 (1.900) |
| Mean | 75.07 (1.869) | 74.74 (1.875) | 78.82 (1.898) | 78.49 (1.898) | 73.45 (1.870) | 73.82 (1.872) | 79.66 (1.901) | 64.99 (1.639) | |

CD 5%

Concentration-0.002

Treatment-0.002

Interaction-0.006

**Studies on Effect of Various Concentration of IAA and IBA on Plant Height in Different Type of Cuttings of *Ocimum Kilimandscharicum***

The effect of different treatments i.e. cutting types treated with auxins , various concentration and interaction of both on plant height in cuttings of *Ocimum kilimandscharicum* were found highly significant under given table 2.

The mean value of plant height (averaged over all concentration) was found maximum (57.82 cm) in apical cutting of 20 cm length treated with IAA. The lowest mean value of plant height (42.51cm) was found in middle portion cutting of 20 cm length treated with IBA.

The mean value of plant height (averaged over all cutting types treated with auxins) was found maximum (52.42 cm) in cuttings treated 400 ppm concentration; however, the lowest mean value of plant height (40.33cm) was recorded in cuttings treated with 2000 ppm concentration of auxins.

Maximum plant height among all treatment combinations (63.50 cm) was obtained in apical cutting of 20 cm length treated with 50 ppm IAA which was found to be statistically at par with 20 cm apical cuttings treated with 500 ppm IAA (63.00cm) , 20 cm middle portion cutting treated with 500 ppm IAA (62.66cm) , 20 cm apical cuttings treated with 200 ppm IAA (61.33 cm) and 20 cm middle portion cutting treated with 2000 ppm IAA (60.50 cm), whereas, lowest plant height (33.80 cm) was found in case control.

**Studies on effect of various concentration of IAA and IBA on collar diameter in different type of cuttings of *Ocimum kilimandscharicum***

The effect of different treatments i.e. cutting types treated with auxins, various concentration and interaction of both on collar diameter in cuttings of *Ocimum kilimandscharicum* were found highly significant under given table 3.

The mean value of collar diameter (averaged over all concentration) was found maximum (0.42 cm) in middle portion cutting of 20 cm length treated with IAA. The lowest mean value of collar diameter (0.27 cm) was found in apical cutting of 10 cm length treated with IBA.

The mean value of collar diameter (averaged over all cutting types treated with auxins) was found maximum (0.36m) in cuttings treated with 400 ppm and 500 ppm concentrations, however, the lowest mean value of collar diameter (0.28 cm) was recorded in cuttings treated with control.

**Table 2: Effect of IAA & IBA on Plant Height of *Ocimum Killimandscharicum***

| Cutting Type | Control | 50 PPM | 100 PPM | 200 PPM | 400 PPM | 500 PPM | 1000 PPM | 2000 PPM | Mean |
|---|---|---|---|---|---|---|---|---|---|
| Apical 10 cm cutting treated with IAA | 41.83 | 58.50 | 49.75 | 50.00 | 46.93 | 47.85 | 46.95 | 43.70 | 48.18 |
| Apical 20 cm cutting treated with IAA | 49.75 | 63.50 | 57.00 | 61.33 | 60.33 | 63.00 | 60.17 | 47.50 | 57.82 |
| Apical 10 cm cutting treated with IBA | 41.83 | 56.75 | 58.50 | 47.25 | 49.25 | 44.00 | 48.25 | 45.00 | 48.85 |
| Apical 20 cm cutting treated with IBA | 49.75 | 58.25 | 57.25 | 50.50 | 52.35 | 55.50 | 51.50 | 0.00 | 46.88 |
| Middle portion 10 cm treated with IAA | 38.45 | 36.00 | 55.85 | 52.00 | 59.00 | 42.00 | 52.00 | 48.00 | 47.91 |
| Middle portion 20 cm treated with IAA | 33.80 | 59.50 | 52.00 | 48.83 | 47.00 | 62.66 | 55.94 | 60.50 | 52.52 |
| Middle portion 10 cm treated with IBA | 38.45 | 41.50 | 42.83 | 43.21 | 57.00 | 40.50 | 47.00 | 37.00 | 43.43 |
| Middle portion 20 cm treated with IBA | 33.80 | 43.66 | 44.17 | 44.75 | 47.50 | 43.75 | 41.50 | 41.00 | 42.51 |
| Mean | 40.95 | 52.20 | 52.16 | 49.73 | 52.42 | 49.90 | 50.41 | 40.33 | |

CD 5%

Concentration-0.797

Treatment -0.797

Interaction -2.256

**Table 3: Effect of IAA & IBA on Collar Diameter of *Ocimum killimandscharicum***

| Cutting Type | Control | 50 PPM | 100 PPM | 200 PPM | 400 PPM | 500 PPM | 1000 PPM | 2000 PPM | Mean |
|---|---|---|---|---|---|---|---|---|---|
| Apical 10 cm cutting treated with IAA | 0.30 | 0.40 | 0.35 | 0.23 | 0.26 | 0.36 | 0.28 | 0.23 | 0.30 |
| Apical 20 cm cutting treated with IAA | 0.20 | 0.52 | 0.20 | 0.26 | 0.26 | 0.35 | 0.27 | 0.23 | 0.28 |
| Apical 10 cm cutting treated with IBA | 0.30 | 0.25 | 0.30 | 0.25 | 0.20 | 0.30 | 0.25 | 0.40 | 0.27 |
| Apical 20 cm cutting treated with IBA | 0.20 | 0.45 | 0.40 | 0.30 | 0.42 | 0.40 | 0.30 | 0.00 | 0.30 |
| Middle portion 10 cm treated with IAA | 0.35 | 0.48 | 0.35 | 0.40 | 0.40 | 0.30 | 0.40 | 0.40 | 0.38 |
| Middle portion 20 cm treated with IAA | 0.30 | 0.50 | 0.40 | 0.26 | 0.45 | 0.53 | 0.46 | 0.50 | 0.42 |
| Middle portion 10 cm treated with IBA | 0.35 | 0.30 | 0.30 | 0.30 | 0.50 | 0.25 | 0.30 | 0.20 | 0.31 |
| Middle portion 20 cm treated with IBA | 0.30 | 0.43 | 0.45 | 0.25 | 0.45 | 0.40 | 0.45 | 0.30 | 0.37 |
| Mean | 0.28 | 0.41 | 0.34 | 0.28 | 0.367 | 0.361 | 0.33 | 0.28 | |

CD 5%

Concentration-0.03

Treatment-0.03

Interaction-0.08

Maximum collar diameter among all treatment combinations (0.53 cm) was obtained in middle portion cutting of 20 cm length treated with 500 ppm IAA which are statistically at par with 20cm apical cutting treated with 50ppm IAA (0.52cm), 20 cm middle portion cuttings treated with 50ppm IBA and 2000ppm IBA (0.50 cm) and 10 cm middle portion cutting treated with IBA (0.50 cm), whereas, lowest collar diameter (0.20 cm) was found in case of 10cm and 20 cm length apical cuttings treated with control.

## SUMMARY AND CONCLUSIONS

The present investigation entitled “Studies on propagation through stem cuttings and effect of biofertilizers on growth of *Ocimum kilimandscharicum* G.”, was carried out in the nursery of College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha during the period 2012-2013. The main objective of the study was:

- To study propagation of *Ocimum kilimandscharicum* G. through cuttings
- To study the effect of different biofertlisers on biomass yield of *Ocimum kilimandscharicum* G.

Under these objectives two experiments were conducted:

- To study the effect of IAA and IBA on growth parameters on different types of cuttings *Ocimum kilimandscharicum* G.
- Studies on the effect of different biofertlisers on growth and biomass yield of *Ocimum kilimandscharicum* G.

In the first experiment the effect of IAA and IBA in different concentrations (50 ppm, 100 ppm, 200 ppm, 400ppm, 500ppm, 1000ppm, 2000ppm and Control) on rootings and growth parameters of apical and middle portion cuttings of *Ocimum kilimandscharicum* G. in two different lengths of 10 cm and 20 cm was studied. The observation were recorded after 3 months of planting of cuttings in polybags for sprouting percentage, plant height(cm), collar dimeter(cm), no. of branches/plant, no.of leaves/plant, fresh shoot biomass(g), oven dry shoot biomass(g), rooting percentage, root length(cm), fresh root biomass(g), oven dry root biomass(g), total fresh biomass(g) and total oven dry biomass(g).

Middle portion Cuttings of 20cm length treated with 2000 ppm IAA showed maximum no.of leaves per plant (94.00), root length (28.50cm), fresh root biomass (3.83 g), oven dry root biomass (1.00g), fresh shoot biomass (33.86g), oven dry shoot biomass (5.58g), total fresh biomass(37.69g) and total oven dry biomass (6.58g). However, Collar diameter (0.50cm) was found to be statistically at par with the maximum value (0.53cm). The cutting type also shows high sprouting percentage (83.66%), plant height (60.50 cm), rooting percentage (80.00%) and no. of branches per plant (3.00).

In the second investigation the effect of various biofertilisers, organic and chemical fertiliser on growth and biomass yield of *Ocimum kilimandscharicum* G. was studied. Eleven different treatments were applied in separate plots with various doses of biofertilisers, organic, chemical fertilizer and without any fertlizer. The observation were recorded for Plant height (cm), Basal diameter (cm), number of branches, number of leaves every month till 6 months and fresh leaf biomass(g), fresh stem biomass(g), root length (cm), fresh root biomass (g), total fresh biomass(g) and Oven dry leaf biomass(g), oven dry stem biomass(g), total oven dry biomass(g) for each plant at the end of 6 months.

Among all treatments plants treated with $T_3$ gave maximum collar diameter (1.35cm), number of branches (15.50), no.of leaves per plant (356.50), fresh leaf biomass per plant(79.16g), fresh stem biomass (300.56g), total fresh biomass(425.28g), fresh leaf biomass yield per hectare (6.59 tonne), oven dry stem biomass (163.69g), total oven dry biomass (201.55g). Plant height (107.81cm), Root length(35.83cm) recorded for $T_3$ are found to be statistically at par with maximum values of plant height (110.40cm) and root length (36.16cm) respectively. It also records higher values in fresh root biomass (45.56g) and oven dry leaf biomass (18.05g).

Among biofertilisers and its combinations, Plants applied with $T_8$ recorded highest Plant height (110.40g), Collar diameter (1.29cm), root length (35.83cm), fresh root biomass (57.80g), fresh leaf biomass (71.65g), fresh stem biomass (238.92g), total fresh biomass (368.37g), fresh leaf biomass yield per hectare (5.97 tonnes), oven dry root biomass (29.33g), oven dry leaft biomass (20.42g), oven dry stem biomass (140.27g), total oven dry biomass (190.02g) and oven dry biomass yield per hectare (1.70 tonne). No. of branches (11.33) and no.of leaf (253.77) were also observed higher values for the respective plant characters among all treatments of biofertilizer applications.

## CONCLUSIONS

On the basis of the result obtained from the present investigation "Studies on propagation through stem cuttings and effect of biofertilizers on growth of *Ocimum kilimandscharicum* G." following conclusion were drawn.

- For production of healthy planting materials of *Ocimum kilimandscharicum* Middle portion Cuttings of 20cm length should be treated with 2000 ppm IAA.
- For maximum growth and yield of fresh leaves producing essential oil and medicinal properties *Ocimum kilimandscharicum* Inorganic fertilizer @2.1gm DAP+2.1gm urea +1.9 gm MOP /plant OR (120Kg N,80Kg P and 80Kg K /Ha) + FYM@60gm/plant should be applied.

- Among biofertilisers, application of Azotobacter @ 3gm/plant +PSB @ 3gm/plant + FYM@60gm/plant resulted maximum plant growth and development and highest herbage yield .

Since the present study was restricted to two growth regulators IAA and IBA with six different concentration for propagation of *Ocimum kilimandscharicum* through cuttings, further work is required to be done by taking more numbers of growth hormones and higher concentration for study.

In the study for the effect of various biofertilisers, organic and chemical fertiliser on growth and biomass yield of *Ocimum kilimandscharicum* further work can be done on mycorrhiza and combinations of chemical, organic and biofertilisers for higher productivity and profit.

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